National Park Service
U.S. Department of the Interior

Rocky Mountain National Park
Continental Divide Research Learning Center

Subalpine Forest Fires and Climatic Variation

The Question: How does fire occurrence relate to climate variability?

Climate can affect fires by creating fire prone conditions like drought. Understanding the relationship between fire occurrence and climate variability can help predict how future climate change scenarios may impact wildfire patterns. The goal was to ascertain the relationships between wildfire occurrences in subalpine forests with (1) climate variability (specifically drought); (2) broad scale climate patterns caused by sea surface temperatures (SST) in the tropical Pacific (El Niño Southern Oscillation or ENSO), north Pacific (Pacific Decadal Oscillation or PDO), and northern Atlantic oceans (Atlantic Multidecadal Oscillation or AMO), which oscillate between relatively warm and cool phases; and (3) temporal variation of sea surface temperatures in the Pacific and Atlantic at short (one to two year) and long (100+ years) time-scales.

Large-scale climate patterns play an important role in the park's fire regime.

The Project: Compare fire history to climate records.

Using dendroecology analyses (tree-cores and fire scar cross sections) and vegetation mapping, Jason Sibold and Thomas Veblen of University of Colorado at Boulder reconstructed the fire history (the year and size of past fires) from 1650 to present for 74,000 acres of subalpine forest in the southern part of the park. They compared the fire history of the park with known tree-ring width data. These tree-ring indices correlate strongly with rainfall and temperature in the region; therefore, tree rings are a good indicator of drought and can be used as a proxy record of climate conditions. Researchers tested for relationships between years in which large fires occurred and (1) drought; (2) broad scale climate patterns, including SSTs; and (3) different combinations of SSTs in the three ocean regions (eight combinations between the three oscillation patterns).

The Results: Large fire events are associated with extreme drought conditions, especially those caused by broad scale climate patterns.

This study suggests that regional changes in precipitation play a major role in large-scale fires in subalpine forests, which take place during extreme regional drought conditions. Large fires in the subalpine are not necessarily related to above average moisture conditions preceding fires, which increase fine fuels like grasses and are essential for fire occurrence in some lower-elevation forest types. These results indicate that large fires in the park depend only on severe drought within the fire year. This is in sharp contrast to the lower-elevation ponderosa pine forests, which typically have fires that follow fuel-enhancing wet periods.

While all three climate patterns (ENSO, PDO, AMO) can result in drought conditions and subsequent fires, the low frequency combination of a year with cold SSTs in the tropical and north Pacific (negative ENSO, aka La Niña, and negative PDO respectively) and warm SSTs in the north Atlantic (positive AMO) is the combination that is most likely to create intense droughts that result in large scale burning. This combination of SSTs occurs in only 17 percent of years; however, 71 percent of the large fires in the park occurred during years of this combination. SSTs in the north Atlantic, which oscillate on a relatively long time scale (50 to >70 years), appear to be the most important climatic pattern associated with multidecadal-scale periods of increased and decreased burning in the park. Fires, therefore, are more likely to occur during periods of warm SST (positive AMO) and less likely during cool SST (negative AMO) even if SSTs in the tropical and north Pacific have SSTs conducive to drought conditions in the region. Interestingly the SST of the north Atlantic has recently switched to warm conditions (positive AMO), which could last for several decades and will likely have implications for upcoming fire seasons in the subalpine.

	ENSO	AMO	PDO
Positive (warm SST)	Wet (El Niño)	Drought*	Wet
Negative (cool SST)	Drought (La Niña)	Wet	Drought

The effects of sea surface temperatures on Rocky Mountain climate. A positive state reflects sea temperatures above normal (warm); a negative state below normal (cool). *Positive AMO is the most important factor in large scale fire occurrence.

This summary is based on published, peer-reviewed and/or unpublished reports available at the time of writing. It is not intended as a statement of park policy or as a definitive account of research results. For more information on the park's research program, see www.nps.gov/romo Written by: Travis Guy Date: June 2006 Updated: January 2008 Photo credit here, if needed. J.S. Sibold and T.T. Veblen. 2006. Relationships of subalpine forest fires in the Colorado Front Range with interannual and multidecadal-scale climatic variation. Journal of Biogeography *33: 833-842.*